Caste, purity, and pollution and the puzzle of open defecation in India: Evidence from a novel measure in a nationally-representative survey

Dean Spears and Amit Thorat*

September 24, 2015

Working Paper

Abstract

Uniquely widespread and persistent open defecation in rural India has emerged as an important policy challenge and puzzle about behavioral choice in economic development. One candidate explanation is the culture of purity and pollution that reinforces and has its origins in the caste system. Although such a cultural account is inherently difficult to quantitatively test, we provide support for this explanation by comparing open defecation rates across places in India where untouchability is more and less intensely practiced. In particular, we exploit a novel question in the 2012 India Human Development Survey that asked households whether they practice untouchability, meaning whether they enforce norms of purity and pollution in their interactions with lower castes. We find an association between local practice of untouchability and open defecation that is robust; is not explained by economic, educational, or other observable differences; and is specific to open defecation, rather than other health behavior or human capital investments more generally. We verify that practicing untouchability is not associated with general disadvantage in health knowledge or access to medical professionals. We interpret this as evidence that the culture of purity, pollution, untouchability, and caste contributes to the exceptional prevalence of open defecation in rural India.

*Spears: Economics and Planning Unit, Indian Statistical Institute, Delhi; Woodrow Wilson School, Princeton University; and r.i.c.e. dean@riceinstitute.org. Thorat: Centre for the Study of Regional Development, Jawaharlal Nehru University.

1 Introduction

A growing literature in development economics identifies early-life health in general (Currie and Vogl, 2013), and exposure to infectious disease in particular (Cutler et al., 2010), as important factors shaping adult human capital and economic productivity.[1] Against this background, it is no surprise that open defecation in India has emerged as a top development and health policy priority. The current draft of the Sustainable Development Goals calls for the elimination of open defecation within 15 years; although the goal is global, it will depend upon rural India, where most people worldwide who defecate in the open live. The Prime Minister of India has set a more ambitious target: eliminating open defecation from India is a flagship priority for his five-year tenure. The World Bank, the Gates Foundation, and other important development funders have allocated considerable resources to this goal. Therefore, it is clear that better understanding the causes of open defecation in India would be a priority for evidence-based policy.

The unique persistence of open defecation in rural India is also a puzzle for the study of behavior and choice in economic development. India has been experiencing rapid economic growth, and people in India are richer, on average, than people in sub-Saharan Africa and many other developing countries in Asia; yet, people in India are considerably more likely to defecate in the open than people in many of these poorer countries. Indeed, many people in rural India who own functioning latrines that meet international quality standards nevertheless choose to defecate in the open (Coffey et al., 2014; Clasen et al., 2014). As an initial illustration of the paradox, consider figure 1, which plots rural open defecation against rural asset wealth for recent Demographic and Health Surveys, each conducted in one country in one year.[2] Of 51 countries poorer than India by this measure, only four small countries

[1] For recent evidence of the importance of sanitation in India for health, see an active literature in economics, including Duflo et al. (2015), Gertler et al. (2015), Geruso and Spears (2015), Hammer and Spears (2013).

[2] In prior work, Coffey et al. (2015) conduct a related exercise, reviewing further cross-country statistical evidence that open defecation in India cannot be accounted for by poverty, average income, education, or governance, which are all better, on average, in India than in many poorer countries where open defecation is

(with a combined population less than 4% as large as India's) have higher rates of rural open defecation than India. No country has a larger difference than India between the open defecation it experiences and what would be predicted based on its wealth. Because India's most recent DHS was in 2005 and open defecation has fallen more quickly in the rest of the world than in India, the puzzle would be even more stark today.

One candidate explanation for the exceptional prevalence and persistence of open defecation in rural India is the culture of purity and pollution that reinforces and has its origins in the caste system (Coffey et al., 2015). Such an explanation is inherently difficult to quantitatively test: culture is a general equilibrium of reinforcing and varying factors, enacted to different degrees and in different ways in different places and times. Ideally, we would want to compare open defecation in the India that exists with open defecation in a hypothetical counterfactual India which had not been influenced by the norms of purity and pollution of the caste system. Instead, what we are able to do in this paper is to compare across places in India where these norms are practiced with greater and lesser intensity.

We exploit a novel question in the 2012 round of the India Human Development Survey: households were asked explicitly whether they practice untouchability, meaning whether they enforce norms of purity and pollution in their interactions with people from the lowest-ranking castes (Thorat and Joshi, 2015). Unlike many prior quantitative studies which document caste discrimination as an *outcome*,[3] we use village average practice of untouchability as an *explanatory variable*, in an effort to understand whether heterogeneity across rural India in the practice of purity and pollution can explain heterogeneity within India in open defecation. To the extent that the effects of purity, pollution, and caste in fact occur

much less common. Kumar et al. (2015) use international and within-Indian comparisons to show that access to water cannot explain open defecation in rural India, either: internationally, four of every five countries with worse access to water have lower levels of open defecation; within India, almost half of rural households with piped water in the home defecate in the open. If providing water were to cause an increase in rates of latrine use in India (Duflo et al., 2015), it would have to be because the culture of purity and pollution gives water different significance in India than in these other countries (Routray et al., 2015).

[3]For example, see Kijima (2006), Thorat and Newman (2007), Hanna and Linden (2012), Hnatkovska et al. (2012), Deshpande and Spears (2016).

in a general equilibrium of widely shared cultural understandings and practices, what we are able to estimate will be a muted effect on a small range of variation. Nevertheless, because the association we find is robust and is specific to a link between the practices of untouchability and open defecation, we believe our results are informative about the puzzle of Indian open defecation. In particular, this paper takes very seriously the possibility that household reports of practicing untouchability could be confounded by knowledge of the health consequences of sanitation or by other dimensions of modernity or development. We show that the practice of untouchability does not similarly predict other health-promoting behaviors and is not associated with disadvantage in health beliefs or in social ties to doctors.

Our paper builds directly on a related recent literature. First, qualitative research by Coffey et al. (2015) advanced the hypothesis that the culture of caste-related purity and pollution in India is importantly responsible for exceptional and continuing rural open defecation.[4] Second, Guiteras et al. (2015) report a field experiment from rural Bangladesh that identifies a role for social forces in sanitation behavior, finding that people are influenced by neighbors' latrine use.[5] Third, Geruso and Spears (2015) document that Muslim households in India are 25 percentage points less likely to defecate in the open than Hindu households, despite being poorer. They exploit this fact to explain a puzzle in the health literature: that despite being poorer, Muslim babies in India are importantly more likely to survive childhood than Hindu babies (Bhalotra et al., 2010). Finally, Thorat and Joshi (2015) use the same survey question on untouchability that we exploit in order to document and describe

[4]This hypothesis has received recent support from Routray et al.'s (2015) new qualitative study of villages in a district of Orissa. Patil et al. (2014) write about a field experiment in rural Maharashtra: "A follow-up debriefing question to households who had IHL [a household latrine] identified that the main reasons for daily open defecation in spite of having IHL were culture, habit, or preference for defecating in open followed by inadequate water availability." Barnard et al. (2013) also note a culturally-influenced preference for open defecation, even among many latrine owners: "The most common reason reported for not using a latrine was that people prefer open defecation. Open defecation is a cultural practice that is deeply engrained in communities in India." See also Teltumbde (2014) on India's current sanitation policy.

[5]Open defecation is considerably lower in Bangladesh than in India, despite the fact that Bangladesh is much poorer. Unicef and the WHO estimate that in 2015 1.8% of rural Bangladeshis defecate in the open. In contrast, our main data sources finds that 64% of Indian households report open defecation. In the Guiteras et al. (2015) study, 78% of the control group reports having access to a toilet or latrine at baseline, compared with 69.3% of rural Indian households having no toilet or latrine in the 2011 Indian census.

the continuing practice of untouchability in India.

To be explicit: this is not a design-based paper, in the sense of Angrist and Pischke (2010), that would use a natural experiment to estimate the exogenous causal effect of untouchability on open defecation. Indeed, we have only approximate measures of the culture of purity and pollution and of open defecation; because of this measurement error, and because of the comparatively small range of variation *within* India, the true effect may be larger than we can document. Instead, we use a unique new data source to shed the first quantitative light on a question of top economic and policy importance: why is open defecation in rural India so uniquely widespread and persistent? We argue that our results are sufficiently able to rule out alternative explanations for the robust and specific association we document that we can interpret this association as evidence that the caste-related culture of purity and pollution is part of what maintains open defecation in rural India. If so, one consequence would be that the practice of casteism has social costs not only for members of disadvantaged castes, but also for all Indians who are impacted by the health externalities of widespread open defecation.

2 Background: Caste, untouchability, and sanitation

India's population is socially characterized by its division into numerous *jatis*. Although some members of other religions claim or are ascribed *jatis*, this system is particularly associated with Hinduism and is outlined in Hindu sacred texts. There exist around 3,000 different *jatis* (also referred to as castes or sub-castes) in India. These numerous kinship groups are socially divided into four broad hierarchical and hereditary groups, ranked in the order of Brahmins (priests) at the top, followed by Kshatriyas (Warriors), Vaishyas (the traders), and Shudras (the workers and farmers) at the bottom. These four groups form the *savarnas*, meaning those who can be ranked according to Hindu religious law. Such rules also define

the precise social and economic rights and duties for each of these groups.[6]

Outside of this four-group classification lies the fifth group: the untouchables (now sometimes called ex-untouchables), the *avarnas*, those who cannot be graded. The ex-untouchables are now constitutionally termed Scheduled Castes, in reference to a schedule (meaning explicit list) of castes in government affirmative action programs that reserve positions in federal jobs and in public institutions of post-graduate higher education. These groups are also known as *Dalits* from a word meaning "oppressed" or "crushed." Dalit groups have traditionally been assigned to specific occupations and have been economically and socially marginalized. Historically, they did not have rights to own land or property, to conduct trade or business, to receive education, or to buy and sell in markets. Such historic disadvantages continue to manifest in Dalits' disadvantage today in nearly all aspects of human development (Deshpande, 2011).

The caste system is justified and enacted according to a cultural set of norms and beliefs surrounding ritual purity and pollution. According to Hindu religious belief, the untouchables are considered to be polluting to the other social groups in part because of the occupations carried out by them in the past, and in some cases still today. Characteristically Dalit occupations such as the manual removal of feces from high-caste homes or the handling of animal corpses are seen to pollute those who undertake them both physically and spiritually.

Aktor (2002) offers an account of purity and pollution in the Hindu caste system. In this view, it is important to maintain the purity of the body of a Brahmin, male, household head in order for him to worship the gods. Certain actions and interactions – especially with people lower ranking in the caste hierarchy of purity – cause him to be polluted. Contact with death and dead bodies, feces, urine, saliva, menstruating women, the cremator of dead bodies, disabled people, foreigners, and especially Dalits are all considered highly polluting.

[6]Although some writers claim that caste is no longer relevant in today's India, there is considerable evidence that, although some implications of caste are changing, caste-based discrimination remains. For example, Deshpande and Spears (2016) document caste-based discrimination among urban, English-speaking internet users.

Caste Hindus must either avoid these situations or subsequently undergo purification rituals, such as particular forms of bathing with clothes on, recitation of chants, or sprinkling of cow urine (Routray et al., 2015).[7] The slightest touch, or even the shadow, of polluted persons is polluting. In contrast with members of higher castes who can be purified, Dalits are permanently polluted.

The ideal form of the Hindu household is organized around a shrine or small temple for prayer. Rural Indians refer to the purity of these shrines when describing why it is defiling and polluting to have a toilet as part of a house (Coffey et al., 2015). Thus, those latrines that exist in rural India are constructed away from the structure of the house, but open defecation – ideally in a field – serves even better to preserve the purity of the home.[8]

So, one mechanism by which the culture of purity and pollution discourages latrine use is the perceived threat of polluting the home by accumulating feces nearby. Another mechanism is concern about the eventual emptying of latrine pits and disposal of accumulated feces. Unlike in other developing countries, where latrine pit emptying is an undesirable or low-status job but is one that is governed by market norms, for caste Hindus it would be inconceivable to empty a latrine pit, or to expect anyone to do so other than a Dalit. However, Dalits are increasingly, if very slowly, resisting assignment to such tasks – the clearest markers of their oppression. Moreover, many rural Indians mistakenly believe standard latrine leach pits will fill an order of magnitude more quickly than is actually the case, requiring frequent emptying, a situation that many find to be highly polluting. As a result, the few latrines one observes in use in rural India are often constructed with very large septic tanks meant to last for decades.

[7]The purifying nature of cow urine is a striking example of the fact that the cultural category of pure versus polluting does not map onto the germ theory of disease. Cow urine and feces are among the most purifying substances; newborn babies and their mothers are polluting even for days after the physical residue of the birth has been cleaned.

[8]Although our paper focuses on rural India, these norms tend to have been modified in urban India, where there is not similar space for open defecation in fields, or for construction of latrines away from the home. Untouchability nevertheless persists in urban India: many Dalits are unable to find work outside of garbage disposal, street cleaning, and maintenance of sewers and toilets.

In short, when many people in rural India compare the costs and benefits of latrine use and open defecation, aspects of the culture of caste-related purity and pollution encourage open defecation. Although further detail on this culture and its practice in rural India is beyond the scope of this econometric paper, Coffey et al. (2015) present a detailed theoretical account of the links between untouchability and open defecation, grounded in semi-structured qualitative interviews across four field sites in India and the plains of Nepal, and with further reference to the existing ethnographic literature on caste and sanitation.[9] An extreme form of the practice of purity and pollution is to treat members of Dalit castes according to the rules of untouchability. The novel survey data collected and reported by Thorat and Joshi (2015) document that many people in rural India readily admit to practicing untouchability. Therefore, we hypothesize that places where the practice of untouchability is more common will be places where open defecation is more common, on average.

Section 3 presents our empirical strategy to test this hypothesis: we compare open defecation behavior of households living in places where larger and smaller proportions of a household's neighbors report practicing untouchability, controlling for a household's own practice of untouchability. Section 4 reports our main result. Section 5 presents a series of tests in which we allow the data to falsify our assumption that the relationship between open defecation and untouchability is specific to sanitation, rather than health investments or "modern" behavior more broadly. Section 6 offers a concluding discussion that considers differences across Indian states and reflects on our results in the internationally comparative context that motivated our analyis.

[9]For statistical evidence an interaction of the caste of local government officials, assigned by random reservation, with outcomes of the Indian government's rural sanitation program, see Lamba and Spears (2013).

3 Data and empirical strategy

3.1 Rural households in the Indian Human Development Survey

We use the 2012 round of the India Human Development Survey (IHDS), a nationally-representative survey of approximately 40,000 households in India, conducted by NCAER and the University of Maryland Sociology department (Desai et al., 2005).[10] The IHDS is unique among nationally representative surveys of India because it combines a full economic consumption module with a wide range of social, health, and human development questions comparable to a Demographic and Health Survey. In particular, the IHDS asks a household-level question about household latrine opership. Following the labeling in the IHDS we dichotomize this question into a binary indicator for household open defecation as our main dependent variable, although we emphasize here that this variable will overlook the well-documented fraction of people who do not use latrines that their household owns (Coffey and Spears, 2014).

We concentrate only on the rural sub-sample, excluding urban households from our analysis. This is because open defecation in India is concentrated in rural India: according to the 2011 census of India, 92% of households without access to a toilet or latrine were rural rather than urban. The IHDS similarly estimates that 89% percent of households reporting defecating in the open in 2012 were rural. Rural India is also widely agreed to be where the policy challenges of open defecation represent choice and behavior, rather than affordability: it is in rural India where open defecation rates vastly exceed what would be predicted by wealth in international comparison, and where people who have the option of using a working latrine often choose to defecate in the open instead (Coffey et al., 2014). Because it is exactly such a behavioral choice that this paper seeks to help understand, our focus on rural

[10]This IHDS is a panel which reinterviewed the same households in 2005 and 2012. However, our analysis largely ignores the 2005 survey because that survey round did not ask about the practice of untouchability. The last Demographic and Health Survey in India was conducted in 2005; therefore, the IHDS is the most recent nationally representative survey data on open defecation in India.

India is appropriate.

3.2 Empirical strategy: Casteism as an explanatory variable

An innovation of the 2012 IHDS is to have asked respondents if their households practice untouchability, meaning whether or not their households enforce norms of purity and pollution in their interactions with Dalits, who are members of the lowest-ranking Indian castes. To our knowledge, no prior large-scale survey in India has measured the practice of untouchability. To be clear, this question was asked to households of all castes: it was intended as a coarse measure of a household's practice of and enforcement of untouchability in interactions with Dalits, not as a measure of whether the household is Dalit, which is asked separately.

Our empirical strategy is to demonstrate first that households that report practicing untouchability are more likely to defecate in the open, and second that villages where more households practice untouchability contain more open defecation. Thus, we estimate:

$$od_{ivs} = \beta_1 practice\ untouchability_{ivs} + \beta_2 \overline{practice\ untouchability}_{vs}^{-i} + X_{ivs}\theta + \alpha_s + \varepsilon_{ivs}, \quad (1)$$

where i indexes individual households, v indexes villages (survey PSUs), and s indexes Indian states. The constructed variable $\overline{practice\ untouchability}_{vs}^{-i}$ is the fraction of households in household i's village other than household i itself which report practicing open defecation.[11] X is a vector of controls, which will vary to demonstrate robustness; α_s are state fixed effects. Because the IHDS is a two-stage sample survey, errors ε_{ivs} will be clustered at the PSU level.

The associations we find are strikingly robust and are not driven by poverty, education, health knowledge, or the caste or religious composition of households or villages. However, we do not claim to have identified any causal effect of casteism on open defecation: both

[11] Note that, although we have an average as an independent variable, our paper does not suffer from the well-known pitfalls of estimating peer effects (Angrist, 2014), for the simple reason that our paper does not estimate a peer effect, the term in the econometric literature for the effect of average peer behavior on an individual's behavior *on that same variable*. We are not estimating the effect of local average practice of untouchability on own practice of untouchability – indeed, we include own practice of untouchability as a control.

our dependent and independent variables are dichotomized measurements with error of complicated and multidimensional phenomena.[12] Rather, we believe that the consistency and specificity of the association between open defecation and the practice of untouchability is evidence that the culture of caste-related purity and pollution, of which untouchability is an extreme manifestation, is an important part of what explains exceptionally widespread and persistent open defecation in India.

Our analysis takes seriously two threats to this interpretation: first, that practicing untouchability is associated with disadvantage more broadly, and second that belief in the norms around untouchability may merely mark failure to believe in the germ theory of disease or other health knowledge that would discourage open defecation. It is true both that poorer people in rural India are more likely to report practicing untouchability and that the culture of purity and pollution includes a theory of the body that is not identical to scientific medical understandings of disease (Alter, 2004).[13] However, the rich data of the IHDS allow us to rule out these more general phenomena. First, in section 5.1, we allow the data the opportunity to falsify our hypothesis of a specific association between casteist practice and open defecation: controlling for socioeconomic status, practicing untouchability fails to similarly predict any of a wide range of health and human development promoting behaviors. Second, in section 5.2, we show that rural Indian households that report practicing untouchability are, if anything, more likely to correctly answer questions about health beliefs and more likely to report knowing a doctor in their family or caste network. These potentially surprising health advantages may be because practicing untouchability is associated with higher caste rank, which is associated with educational advantage. These advantages in health knowledge do relevantly predict less open defecation behavior; however, accounting for them does not

[12]For the independent variable, the belief in caste-oriented norms of purity and pollution and the practice of untouchability both take many forms and degrees. For the dependent variable, open defecation is an individual-level behavior, which varies within households across people and with seasons and other occasions (Coffey et al., 2014).

[13]We take no position on whether people can simultaneously hold beliefs compatible with the germ theory of disease and with the Hindu theory of the body; our point here is only to verify that our measure of the practice of untouchablility is not merely a marker for failure to believe in the germ theory of disease.

change the association between practicing untouchability and open defecation. Therefore, we show that the association between widespread local practice of untouchability and open defecation is statistically robust, is specific to open defecation among health and human development behaviors, and does not merely reflect general health knowledge or belief.

3.3 Summary statistics

Table 2 presents summary statics from the IHDS. We present results for the full sample, and separated by answers to the IHDS untouchability questions. The survey asks two questions:

- In your household do some members practice untouchability?
- *if no*: Would there be a problem if someone who is scheduled caste were to enter your kitchen or share utensils?

Throughout the paper, we will use two measures of household untouchability practice, to verify robustness. We will call "untouchability A" an answer of yes to the first question; we will call "untouchability B" an answer of yes to either question. By construction, untouchability B will be a larger fraction of households than untouchability A. Note that because untouchability is measured at the household level, it will capture with error cases where some household members practice untouchability and others do not. Moreover, practiced untouchability may exceed reported untouchability if some people who practice untouchability did not admit this to the surveyor.

Appendix figure A1 provides an approximate validation of households' reports of practicing untouchability. Dalit households – which would be the households eligible for discrimination and for receiving the practice of untouchability – were asked "In your household have some members experienced untouchability in the last 5 years?". As the figure shows, Dalit respondents are more likely to report *experiencing* untouchability if they live in villages where a larger fraction of the other households report *practicing* untouchability.

As the summary statistics table shows, almost two-thirds of rural households report defecating in the open. These rural households are largely in the agricultural economy and are 84% Hindu; Muslims in India are relatively more likely to live in urban places. Only three-fourths of households have a literate member and only about two-fifths have a person who reads the newspaper.

Explicit reporting of practicing untouchability to the IHDS surveyor is common in this rural sample: 24% of respondents openly reported practicing untouchability; 31% said yes to this question or to the kitchen question. The summary statistics in the table allow simple comparisons of means between households that do and do not report practicing untouchability, without any regression controls. The comparison for untouchability B is particularly striking: households that practice untouchability have only 4 percent less consumption per capita, are only one percentage point less likely to have a literate adult, and are not at all less likely to have a primary schooled adult or a man who reads the newspsper; none of these differences are statistically significant from zero. Yet, they are 10 percentage points more likely to report defecating in the open, a difference with a t-statistic of 6.8. Thus, these summary statistics are initial evidence of a specific association between open defecation and the practice of untouchability, which will be further investigated in the remainder of this paper.

4 Results

4.1 Main result: Local casteism and open defecation

4.1.1 Household-level differences

Because we are interested in the consequences of rural India's widely shared culture of purity, pollution, and caste, our main results will focus on $\overline{practice\ untouchability}_{vs}^{-i}$, the fraction of a household's neighbors that report practicing untouchability. However, in this section we

begin with a simple comparison of households that do and do not practice untouchability, to permit a visual demonstration that these differences are not obviously confounded by education or wealth.

Figure 2 plots local regressions of the fraction of households that defecate in the open at different levels of consumption and of education, with those that do and do not report practicing open defecation plotted separately. The solid lines are for households that report practicing untouchability; the dashed lines are for households that do not. In each graph, all lines slope downwards, consistent with the familiar fact that richer and better educated households are less likely to defecate in the open. The vertical distance between the lines is evidence of an association between the norms of untouchability and open defecation that is not able to be explained by consumption or education. For example, the vertical distance between the lines in panel (a) at 10.5 is large: this corresponds to an average annual consumption per person of about $700 at market exchange rates[14] and is the 89th percentile of households in our data. The international experience of much lower open defecation rates in poorer countries is clear evidence that nearly all such households could afford to construct and use a toilet, but those who do not practice untouchability are much more likely to do so. Similarly, note that a majority of households *with a 10th-pass high school graduate* defecate in the open; open defecation among this relatively privileged minority exceeds the fraction of all people in rural sub-Saharan Africa who defecate in the open, including the poorest.

Panels (c) and (d) restrict the sample to the 84% that are Hindu. Hindu households in our sample are more than twice as likely as non-Hindu households to report practicing untouchability: 33% of Hindus, versus 15% of non-Hindus. Similarly, 14 percentage points more of the average Hindu household's neighbors report practicing untouchability than the average non-Hindu household's neighbors. However, the norms of purity and pollution are enacted

[14]Computed as $e^{10.5} \div 50\frac{\text{rupees}}{\text{dollar}} = \$726$. Adjusting for purchasing power parity would make this number larger. Such a household with five people could afford the expensive 12,000 rupee latrines that the Indian government purchases by reducing one year's consumption by 3.5%, or the average-price latrine that Cameron et al. (2013) document being in use in Indonesia by reducing one year's consumption by 1.3%.

among non-Hindus, and are enacted with varying intensity among Hindus. These bottom panels verify that untouchability is not merely a marker for dichotomized Hinduism *per se*, and that heterogeneity in these norms within Hindus predicts heterogeneity in sanitation behavior.

4.1.2 Village average practice of untouchability

Table 3 presents the main result of this paper. Before this, the first two columns verify the statistical significance and robustness of the difference across households presented in figure 2. The approximately 9 percentage point average difference in open defecation rates between households that do and do not practice untouchability is essentially unchanged by adding controls for a cubic polynomial of consumption per capita and indicators for 35 combinations of caste rank and religion (such as for being a Hindu Brahmin or a Muslim OBC). Thus, this result does not merely reflect the household's own wealth, religion, or caste rank.

Column 3 introduces our main independent variable: fraction of households in the PSU *other than the respondent* who report practicing untouchability. We interpret this variable as a measure of the intensity of the cultural norms of caste-related purity and pollution in a place. Households living in villages where all of their neighbors practice untouchability are over 30 percentage points more likely to defecate in the open than households living in villages where none of their neighbors practice untouchability. Once village untouchability is added to the model, the coefficient on own household practice of untouchability becomes much smaller and not statistically significantly different from zero. The coefficient on village untouchability becomes smaller when a large set of economic, educational, demographic, and caste variables are added, but remains of important magnitude. Comparing column 4 with column 7 and column 5 with column 8, we see that the coefficient on village untouchability is essentially unchanged if the sample is restricted to Hindus.

The importance for rural life of caste-based norms of purity and pollution varies geographically across India. As the last two rows of the summary statistics table 2 shows, 60%

of households that report practicing untouchability live in northern plains states (which are home to 37% of rural households); households that report not practicing untouchability are statistically significantly more likely to live in southern states. Overall, a set of indicators for each state can account for 17 percent of the variation in the practice of untouchability across the rural households we study. Therefore controlling for state fixed effects absorbs much of the variation that is important both in the culture of purity and pollution and in open defecation. That said, column 6 of table 3 shows that village average practice of untouchability remains associated with open defecation behavior, even within states and after accounting for our set of extended controls.

One potential concern about this specification is measurement error: we observe only a dichotomized indicator of the practice of untouchability, itself only one dimension of norms of purity and pollution. This is not a debilitating concern because it is not our goal to uncover a "causal effect of untouchability;" rather, we intend to provide evidence of the importance of the culture of purity and pollution to open defecation in rural India. That said, if as a partial response to measurement error we use household and village untouchability A to instrument for untouchability B in the fully controlled specification of column 6, the coefficient on village untouchability rises slightly to 0.080 with a standard error of 0.029.

Figure 3 permits us to assess the linearity of the relationship between village untouchability and open defecation, implicitly assumed by our regression framework, and to visualize the robustness of the relationship to regression controls. The graph plots the fraction of households defecating in the open at each level of village untouchability, where village untouchability has been residualized after regression on various sets of controls. In other words, the four horizontal-axis variables in the figure are:

- the fraction of households reporting practicing untouchability, demeaned by the average across villages,
- the village-level average of the household-level residuals after regressing an indicator

for practicing untouchability on indicators for eight caste and religion groups,

- the average of the residuals after regressing an indicator for practicing untouchability on the same household-level indicators and seven continuous variables for the fraction of village households in each of these groups, and
- the average of the residuals after regressing an indicator for practicing untouchability on all of the previous variables and household consumption.

The figure shows that the shape of the association between village practice of untouchability and caste is robust to these controls for caste itself and for household consumption. Village practice of untouchability does not merely reflect the caste or religion composition of the village.

4.2 Village-level decline in open defecation, 2005-2012

Over the seven years between the first and second waves of the IHDS, open defecation in rural India declined by 7.4 percentage points. This rate of about one percentage point per year approximately matches the decline from 78.1 in the 2001 census of India to 69.3 in the 2011 census. Because the practice of untouchability was not measured in the 2005 round of the IHDS, we cannot observe whether change in the practice of untouchability predicts change in open defecation, although we would expect such a longstanding and pervasive norm to change only slowly.

Instead, table 4 investigates whether the village-level decline in open defecation, measured as a percent of the 2005 level of open defecation, was greater on average in villages where the 2012 fraction of the village reporting practicing untouchability is greater. Indeed, the table shows that the average decline was less than half as large in villages where all households reported practicing open defecation than in villages where no households did. Controls added in columns 2 and 3 verify that this result is not due to differences in economic change over this period or in baseline levels of open defecation. Column 4 adds controls for the fraction

of the village belonging to each of eight caste and religion population groups. If anything, this slightly increases the coefficient on untouchability, suggesting that it is not merely a spurious marker for village composition.

5 Falsification tests

We interpret the robust relationship between village average practice of untouchability and open defecation as evidence that the culture of caste-related purity and pollution is important for the continuing high levels of open defecation in India. This section presents two tests of alternative hypotheses that could falsify our interpretation. First, we test whether the association between casteism and open defecation is specific, or whether the practice of untouchability similarly predicts a wide range of behaviors associated with traditional lifestyles, disadvantage, or health and human capital. Second, we have seen that untouchability does not merely reflect education; we further test whether the practice of untouchability is merely a marker for incorrect beliefs about what would promote health.

5.1 Specificity of the casteism-sanitation association

Figure 4 summarizes results from regressions of the form of equation 1 with 20 separate dependent variables substituted in turn, with the full set of controls from column 6 of the main results table 3. Each regression is repeated for untouchability A and B, so the graph represents 40 separate regressions. Points in the graph are the absolute value of the t-statistic on the independent variable of interest $\overline{practice\ untouchability}_{vs}^{-i}$, for the two measures of untouchability. The dotted lines are at the t critical value 1.96. The 20 substituted dependent variables, each as reported by the household, are:

open defecation	ideal fertility
always washes hands	prefers that next child is a boy
woman's age at marriage	currently using contraception

took loan in the last five years	unmarried girls harassed in village
owns cell phone	health belief about milk in pregnancy
does seasonal migration work	health belief about male sterilization
socially knows a doctor	health belief about colostrum
socially knows another health worker	health belief about *chulha* smoke
member in women's group	last birth at home (not institutional)
cooks in a separate kitchen	last birth exclusively breastfed (6mo.)

As the figure shows, only open defecation is consistently statistically significantly predicted by village practice of untouchability, among these measures of health beliefs and behaviors, modernity, and social conservatism. Belief about the health consequences of smoke from traditional stoves, called *chulhas*, is associated with untouchability A, but in the opposite direction: respondents living in villages where more people report practicing untouchability are more likely to correctly answer that *chulha* smoke is harmful for health. These results are consistent with a specific cultural association between open defecation and caste-related institutions of purity and pollution.

5.2 Health beliefs and the germ theory of disease

Our motivating assumption is that practicing untouchability is a marker for a set of beliefs or preferences which is not merely a marker for modernity, education, or correct knowledge about health. This section presents a series of tests designed to allow the data to falsify these assumptions. This opportunity is provided by the IHDS's unique combination of health questions, economic questions, and social questions about households' social networks.

5.2.1 Practicing untouchability is associated with *correct* answers to health questions

Table 5 tests the hypothesis that people living in villages where more people practice untouchability know less about health issues relevant to life in rural India. The IHDS women's survey includes questions about health beliefs. For example, the survey asks "Is it harmful to drink 1-2 glasses of milk every day during pregnancy?" and "Which of the following spreads Malaria? Contact with sick person, drinking impure water or mosquitos?". We constructed a set of indicator variables for correct answers to these questions.

Panels A and B of table 5 present, separately for each health belief question, results of regressing an indicator for answering the question correctly on our standard measures of the practice of untouchability and on every control variable included in column 6 of table 3. In six of these twelve regressions, the coefficient on village untouchability practice is sufficiently large and precisely estimated to be distinguishable from zero; in each of these cases the coefficient is positive. Including statistically insignificant results, 10 of the 12 coefficients are positive; there is only a 2% chance of seeing a result this extreme if all coefficients are equally likely to be positive or negative.

These results suggest that village adherence to norms of purity and pollution is, if anything, associated with better health knowledge. In contrast, Panel C substitutes an indicator for household open defecation instead of the untouchability variables. Three coefficients are positive and three are negative, with no clear pattern to the results, suggesting that the 2012 level of open defecation is not strongly associated with the health beliefs measured in the IHDS.

5.2.2 Practicing untouchability is associated with social ties to doctors

In a section of the IHDS designed to measure social networks, the survey asks "Do you or any members of your household have personal acquaintance with someone who works in any of the following occupation among your relatives/caste/community," with "doctors" as one

of the occupations asked about.[15] Table 6 finds that households that practice untouchability are about two percentage points more likely to report knowing a doctor. Columns 2 through 4 verify that this difference is not driven by consumption, the caste or religion of the respondent as measured by the IHDS, by state differences, or by an omitted correlation with dichotomized Hinduism.[16] Thus, this measure also suggests that practicing untouchability is positively associated with some dimensions of greater access to health information.

5.2.3 Controlling for health knowledge does not change our main result

Table 7 adds the measures of health beliefs and social relationships with a doctor to our main regression results. Because not every household contained a woman who answered the health belief questions, adding these variables reduces our sample. The health belief questions collectively improve the fit of the model. However, the main coefficients on village average practice of untouchability are numerically almost unchanged by the addition of these controls. Again, there is no evidence here to suggest that the association between open defecation and the norms of untouchability merely reflects general health knowledge or interaction with the germ theory of disease.

6 Discussion: Explaining heterogeneity across states

Our analysis of open defecation in rural India is motivated by the puzzle of exceptionally high open defecation there, in international comparison. However, this paper exploits variation *within* India in the culture of caste-related purity and pollution in order to suggest that the presence of these issues might be part of what explains the internationally unusual amount of open defecation in India. As in the international case, there are also apparent

[15]The "socially knows a doctor" variable in falsification figure 4 is an indicator for knowing a doctor in your relative, caste, or community group, *or otherwise*.

[16]However, the IHDS's indicator for being "Brahmin" is coarse relative to the many subdivisions of caste, and within this and other IHDS categories further caste privilege may be residually correlated with educational or other social advantage.

paradoxes within India, in comparisons across Indian states. States which are generally regarded to be relatively well-governed and less poor such as Gujarat and Tamil Nadu have rural open defecation rates[17] in the 2011 census of 67.0% and 76.8%, respectively, not far behind the 78.2% and 82.4% of Uttar Pradesh and Bihar, poor norther states. In contrast, the northeastern states – which are poor and marked by governance challenges, but are in some ways culturally dissimilar to the Indian mainland – have much lower rates of rural open defecation, such as 15.9% in Sikkim, 14.0% in Manipur, 15.4% in Mizoram. In the IHDS, reported practice of untouchability is 9 percentage points lower, on a base of 24, in the northeastern states than in the Indian mainland.

If familiar socioeconomic variables cannot explain heterogeneity across Indian states, can the culture of purity and pollution, as measured here by reported practice of untouchability? Table 8 suggests that the answer may be yes. Column 1 shows that state average practice of untouchability can linearly account for 48% of the variation in state average open defecation. In column 2, when a control for literacy rates is added, these two variables can together explain over 70% of the cross-state variation. Adding a set of controls for economic standard of living in column 3 (average consumption and fraction below the poverty line) does not improve the explanatory power of the model; nor does a set of controls for governance and civil society (fractions with much and with some confidence in politicians, fraction receiving NREGA work, fraction in a women's group).

The aggregated regressions with controls in columns 5 and 6 may capture the general equilibrium effects of the culture of purity and pollution in India in a way that the household level regressions of our main results cannot. If so, and if these regressions are not importantly confounded by omitted variables, they may be informative about our motivating questions about India in international comparison. Although this computation is suggestive and should not be taken quantitatively literally, it may be informative about the potential importance

[17]In fact, the census measured household latrine ownership, not the behavior of open defecation or latrine use.

of untouchability to imagine what open defecation in India would look like without the culture of purity and pollution. According to Unicef and WHO Joint Monitoring Program data, 35.2% of rural sub-Saharan Africa defecated in the open in 2012. Presumably, almost nobody in rural sub-Saharan Africa practices India untouchability. The predicted amount of open defecation in rural India with untouchability set to zero would be:

$$\underbrace{64\%}_{\substack{\text{IHDS average O.D.}\\ \text{(table 1)}}} - \underbrace{31\%}_{\substack{\text{untouchability B}\\ \text{(table 1)}}} \times \underbrace{0.549}_{\substack{\text{regression coefficient}\\ \text{(table 8, col. 4)}}} = 47.2\%. \quad (2)$$

This would mean that our dichotomized measure of the practice of untouchability could linearly account for 59% of the difference between India and sub-Saharan Africa in open defecation. Given the measurement error in our simple measure of the culture of purity and pollution, this would plausibly be an underestimate of the effect size. Of course, this computation should not be taken at all numerically literally; among other abstractions, it does not account for any other difference between India and sub-Saharan Africa and it is not the purpose of this paper to estimate a causal effect. But this projection does suggest that purity and pollution could be an important part of what makes sanitation in rural India unique.

References

Aktor, Mikael. 2002. "Rules of untouchability in ancient and medieval law books: Householders, competence, and inauspiciousness." *International Journal of Hindu Studies*, 6(3): 243–274.

Alter, Joseph S. 2004. *Yoga in modern India: The body between science and philosophy*: Princeton University Press.

Angrist, Joshua D. 2014. "The perils of peer effects." *Labour Economics*, 30: 98–108.

Angrist, Joshua D and Jorn-Steffen Pischke. 2010. "The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics." *Journal of Economic Perspectives*, 24(2): 3–30.

Barnard, Sharmani, Parimita Routray, Fiona Majorin, Rachel Peletz, Sophie Boisson, Antara Sinha, and Thomas Clasen. 2013. "Impact of Indian Total Sanitation Campaign on Latrine Coverage and Use: A Cross-Sectional Study in Orissa Three Years following Programme Implementation." *PLOS ONE*.

Bhalotra, Sonia, Christine Valente, and Arthur Van Soest. 2010. "The puzzle of Muslim advantage in child survival in India." *Journal of Health Economics*, 29(2): 191–204.

Cameron, Lisa, Manisha Shah, and Susan Olivia. 2013. "Impact Evaluation of a Large-Scale Rural Sanitation Project in Indonesia." Policy Research Working Paper 6360, World Bank.

Clasen, Thomas, Sophie Boisson, Parimita Routray, Belen Torondel, Melissa Bell, Oliver Cumming, Jeroen Ensink, Matthew Freeman, Marion Jenkins, Mitsunori Odagiri et al.. 2014. "Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection, and child malnutrition in Odisha, India: a cluster-randomised trial." *The Lancet Global Health*, 2(11): e645–e653.

Coffey, Diane and Dean Spears. 2014. "How can a large sample survey monitor open defecation in rural India for the Swatch Bharat Abhiyan?" working paper, r.i.c.e.

Coffey, Diane, Aashish Gupta, Payal Hathi, Nidhi Khurana, Dean Spears, Nikhil Srivastav, and Sangita Vyas. 2014. "Revealed preference for open defecation." *Economic & Political Weekly*, 49(38): 43.

Coffey, Diane, Aashish Gupta, Payal Hathi, Dean Spears, Nikhil Srivastav, and Sangita Vyas. 2015. "The puzzle of widespread open defecation in rural India: Evidence from new qualitative and quantitative data." working paper, r.i.c.e. (www.riceinstitute.org).

Currie, Janet and Tom Vogl. 2013. "Early-Life Health and Adult Circumstance in Developing Countries." *Annual Review of Economics*, 5(1): 1–36.

Cutler, David, Winnie Fung, Michael Kremer, Monica Singhal, and Tom Vogl. 2010. "Early-life malaria exposure and adult outcomes: Evidence from malaria eradication in India." *American Economic Journal: Applied Economics*: 72–94.

Desai, Sonalde, Amaresh Dubey, and Reeve Vanneman. 2005. "India Human Development Survey-II." computer file, University of Maryland and National Council of Applied Economic Research.

Deshpande, Ashwini. 2011. *The grammar of caste: economic discrimination in contemporary India*: Oxford University Press.

Deshpande, Ashwini and Dean Spears. 2016. "Who is the Identifiable Victim?: Caste and Charitable Giving in Modern India." *Economic Development and Cultural Change*.

Duflo, Esther, Michael Greenstone, Raymond Guiteras, and Thomas Clasen. 2015. "Toilets Can Work: Short and Medium Run Health Impacts of Addressing Complementarities and Externalities in Water and Sanitation." working paper 21521, NBER.

Gertler, Paul, Manisha Shah, Maria Laurz Alzua, Lisa Cameron, Sebastian Martinez, and Sumeet Patil. 2015. "How does health promotion work? Evidence from the dirty business of eliminating open defecation." working paper 20997, NBER.

Geruso, Michael and Dean Spears. 2015. "Neighborhood Sanitation and Infant Mortality." working paper 21184, NBER.

Guiteras, Raymond, James Levinsohn, and Ahmed Mushfiq Mobarak. 2015. "Encouraging sanitation investment in the developing world: A cluster-randomized trial." *Science*, 348(6237): 903–906.

Hammer, Jeffrey S and Dean Spears. 2013. "Village sanitation and children's human capital: evidence from a randomized experiment by the Maharashtra government." Policy Research Working Paper 6580, World Bank.

Hanna, Rema N and Leigh L Linden. 2012. "Discrimination in grading." *American*

Economic Journal: Economic Policy, 4(4): 146–168.

Hnatkovska, Viktoria, Amartya Lahiri, and Sourabh Paul. 2012. "Castes and Labor Mobility." *American Economic Journal: Applied Economics*, 4(2): 274–307.

Kijima, Yoko. 2006. "Caste and tribe inequality: evidence from India, 1983–1999." *Economic Development and Cultural Change*, 54(2): 369–404.

Kumar, Manish, Rinku Murgai, and Dean Spears. 2015. "Access to water does not explain exceptionally common open defecation in India." working paper, World Bank.

Lamba, Sneha and Dean Spears. 2013. "Caste, 'cleanliness' and cash: effects of caste-based political reservations in Rajasthan on a sanitation prize." *Journal of Development Studies*, 49(11): 1592–1606.

Patil, Sumeet R, Benjamin F Arnold, Alicia L Salvatore, Bertha Briceno, Sandipan Ganguly, John M Colford Jr, and Paul J Gertler. 2014. "The effect of India's total sanitation campaign on defecation behaviors and child health in rural Madhya Pradesh: a cluster randomized controlled trial." *PLoS medicine*, 11(8): e1001709.

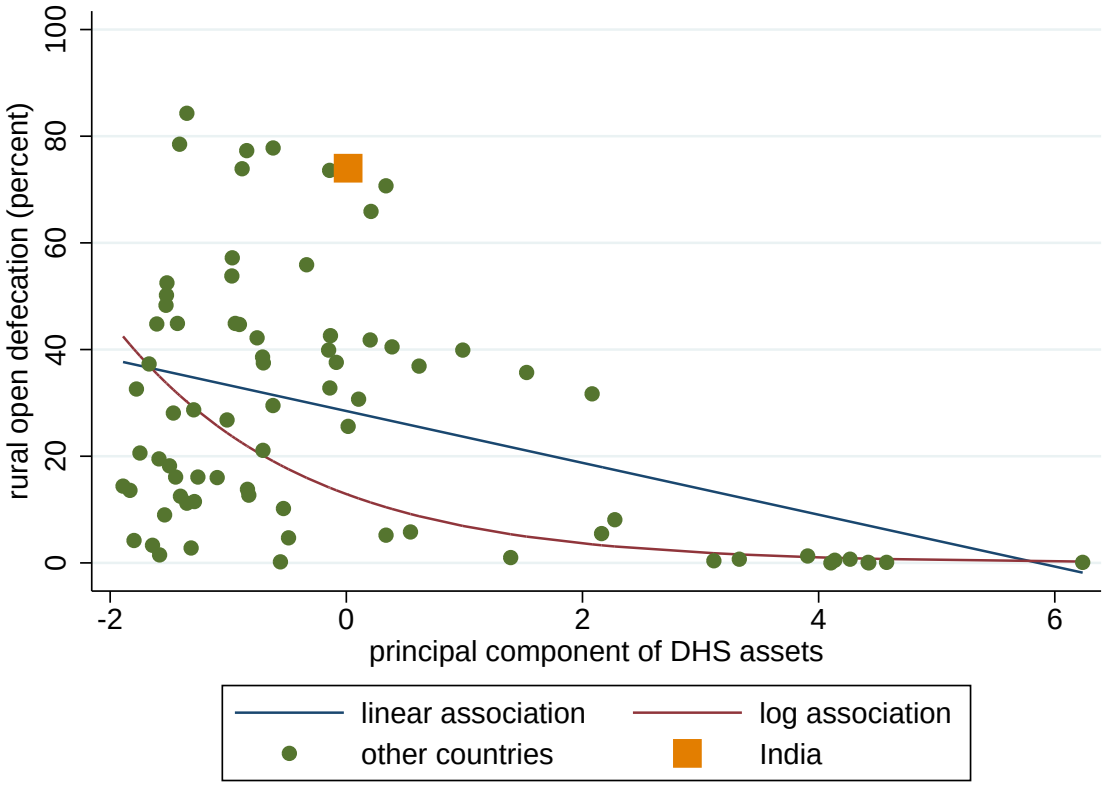
Routray, Parimita, Wolf-Peter Schmidt, Sophie Boisson, Thomas Clasen, and Marion W Jenkins. 2015. "Socio-cultural and behavioural factors constraining latrine adoption in rural coastal Odisha: an exploratory qualitative study." *BMC public health*, 15(1): 880.

Teltumbde, Anand. 2014. "No Swachh Bharat without Annihilation of Caste." *Economic and Political Weekly*.

Thorat, Amit and Omkar Joshi. 2015. "The Continuing Practice of Untouchability in India: Patterns and Mitigating Influences." India Human Development Study Working Paper 2015-03, NCAER.

Thorat, Sukhadeo and Katherine S Newman. 2007. "Caste and economic discrimination: causes, consequences and remedies." *Economic and Political Weekly*: 4121–4124.

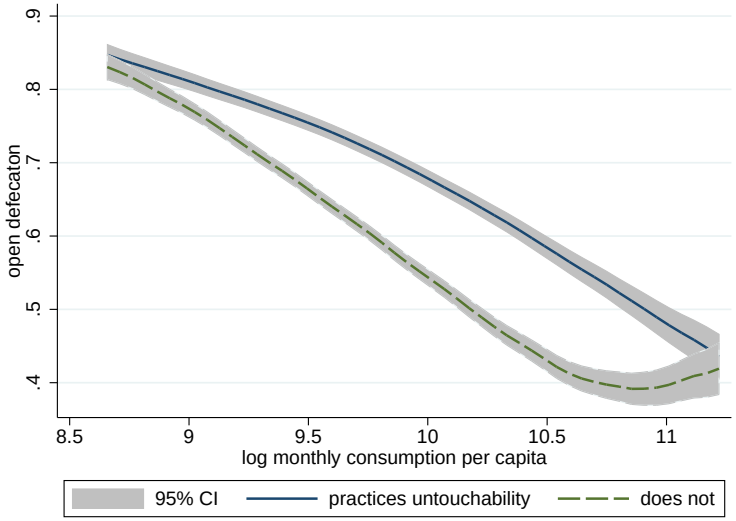
Figure 1: The puzzle: Open defecation in India in international comparison



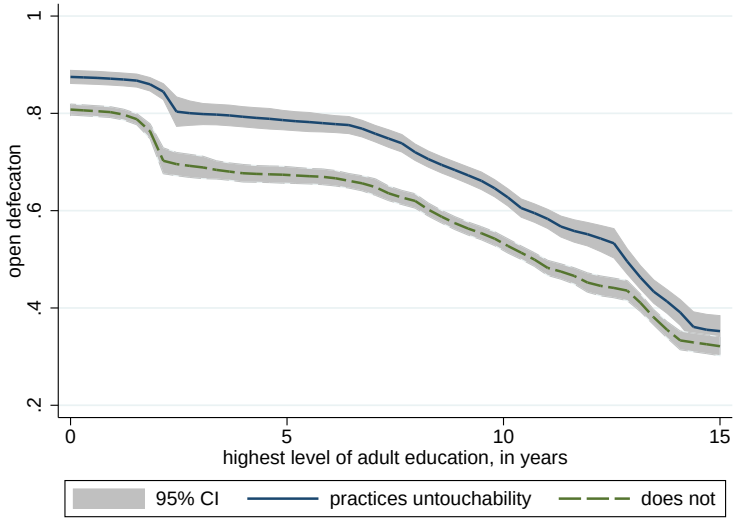
Each observation represents one Demographic and Health Survey, which is a country in a year. Most of these surveys are from sub-Saharan Africa. All 77 surveys which observe toilet facilities, electrification, and ownership of radio, television, mobile phone, any phone, and refrigerator are included. The horizontal axis is the first principal component of the non-toilet assets. The four countries with higher unconditional rural open defecation than India are Benin, Burkina Faso, Namibia, and Niger, which collectively have a combined population less than 4% of that of India. The linear specification has an R^2 of 15%; the log specification has an R^2 of 44%. Open defecation in India in 2005 was 61 percentage points greater than would be predicted by the first principal component of these assets in the log specification, which is the largest residual among these observations.

Figure 2: Household untouchability practice and open defecation, at all levels of consumption and education

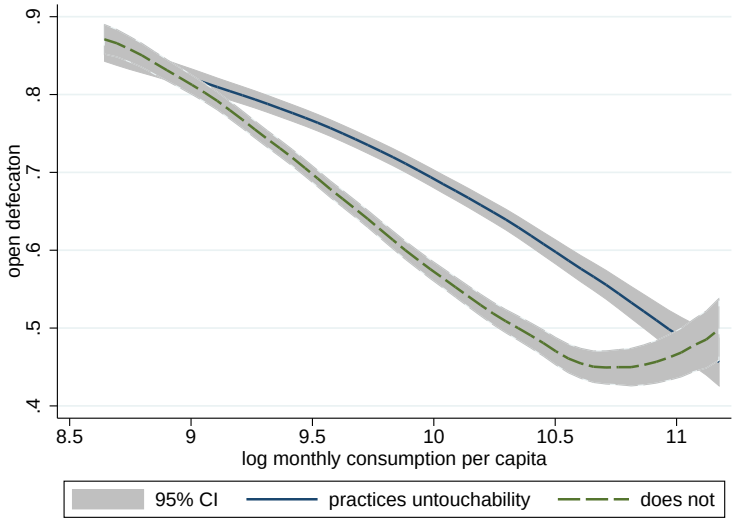
(a) consumption, all rural households



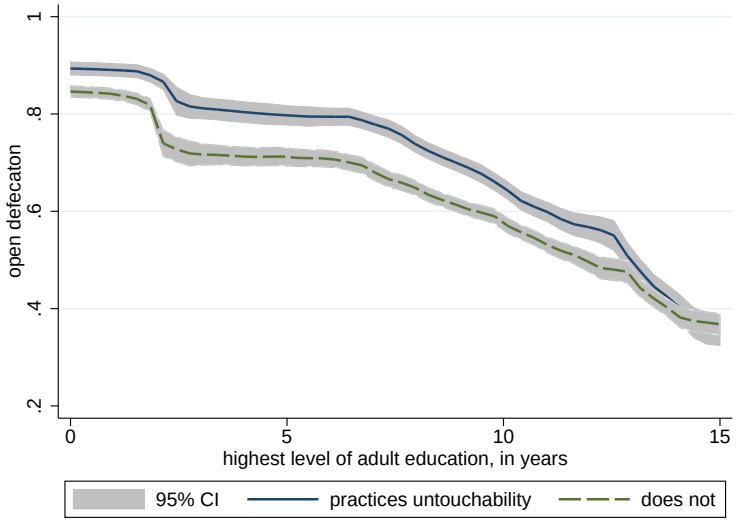
(b) education, all rural households



(c) consumption, rural Hindu households



(d) education, rural Hindu households



Samples are split by untouchability B: reported practice of untouchability directly or of not allowing a Dalit in the kitchen.

Figure 3: Village average untouchability practice and open defecation

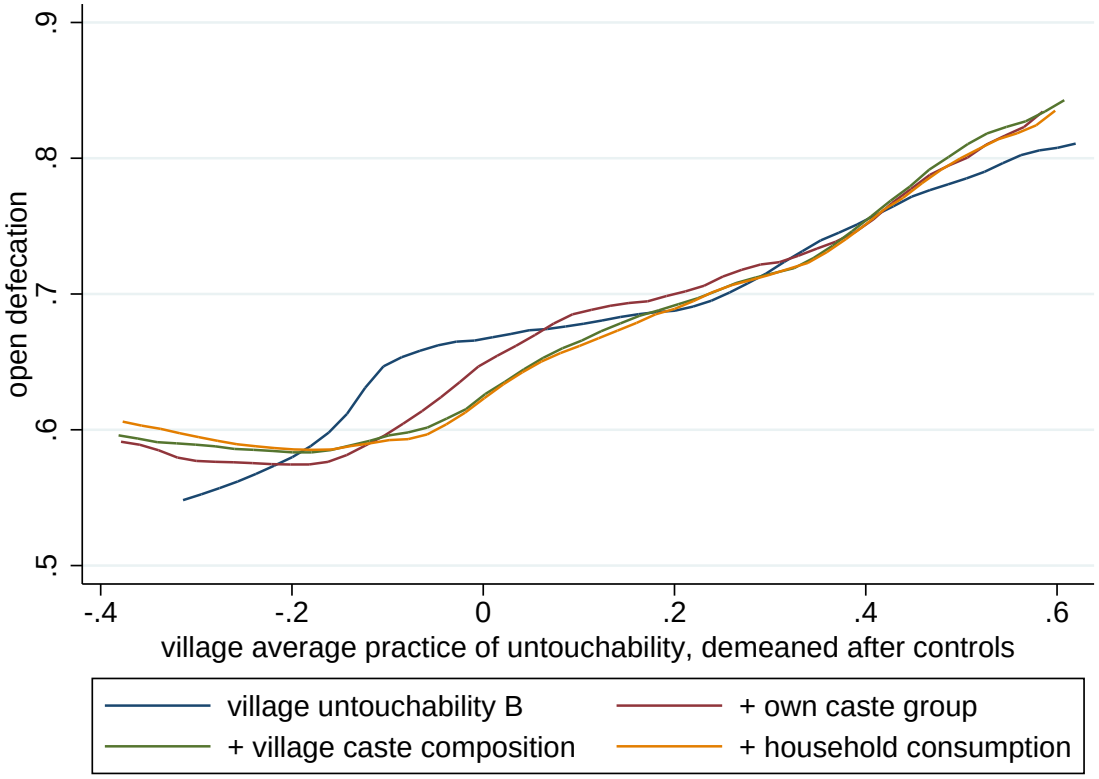
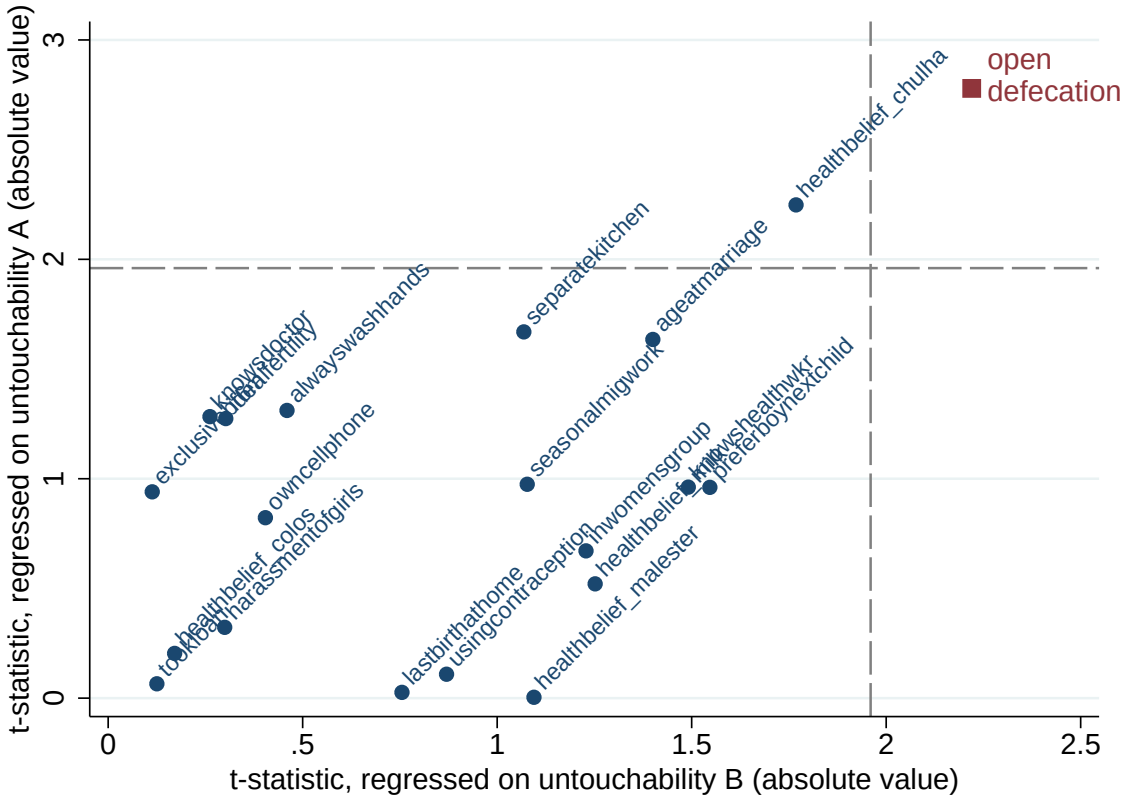


Figure 4: Local untouchability practice does not similarly predict other outcomes



Observations in this graph are the absolute value of t-statistics on village average practice of untouchability from 40 regressions of the form of equation 1 with each named variable substituted in turn for the dependent variable.

Table 2: Summary statistics, IHDS 2012

		untouchability A: 24%			untouchability B: 31%		
	mean	yes	no	t-statistic	yes	no	t-statistic
open defecation	0.64	0.71	0.62	6.57	0.71	0.61	6.82
consumption per capita	21,511	20,339	21,873	-2.60	20,784	21,830	-1.86
ln(consumption per capita)	9.73	9.69	9.74	-2.36	9.70	9.74	-1.55
own or cultivate land	0.61	0.73	0.57	11.33	0.72	0.56	12.54
household size	4.77	4.91	4.73	3.01	4.93	4.70	4.23
any literate adult	0.75	0.73	0.75	-2.55	0.74	0.75	-1.30
any primary schooled adult	0.68	0.66	0.68	-1.44	0.68	0.68	0.04
men read newspaper	0.41	0.40	0.41	-0.60	0.41	0.41	0.31
women read newspaper	0.19	0.16	0.20	-3.39	0.16	0.20	-3.11
Hindu	0.84	0.93	0.82	9.23	0.92	0.81	8.86
Muslim	0.10	0.05	0.11	-6.09	0.06	0.12	-5.47
Brahmin caste	0.04	0.09	0.03	8.08	0.08	0.02	8.38
OBC	0.42	0.52	0.39	7.83	0.53	0.37	9.28
Scheduled Caste/Dalit	0.24	0.12	0.27	-10.48	0.13	0.28	-11.14
Scheduled Tribe/Adivasi	0.11	0.08	0.12	-3.02	0.08	0.12	-2.93
northern plains state	0.37	0.60	0.30	14.13	0.58	0.28	14.29
southern state	0.21	0.10	0.24	-8.53	0.12	0.24	-6.51
n rural households	27,322	6,507	20,815		8,681	18,642	

t-statistic tests whether the mean is the same for households that do and do not report practicing untouchability; standard errors clustered by survey PSU. "Untouchability A" is reporting practicing untouchability; "Untouchability B" is "Untouchability A" or reporting not allowing a dalit into the kitchen.

Table 3: Main result: Open defecation among rural households and village untouchability practice, IHDS 2012

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
sample:	full	full	full	full	full	full	Hindu	Hindu
Panel A: Untouchability A (directly reported)								
household untouchability	0.0967***	0.0879***	-0.00662	0.0196†	0.0000556	-0.00276	0.0195†	-0.000236
	(0.0147)	(0.0136)	(0.0102)	(0.0102)	(0.0101)	(0.00961)	(0.0108)	(0.0107)
village untouchability^{-i}			0.336***	0.233***	0.182***	0.0743**	0.228***	0.178***
			(0.0335)	(0.0320)	(0.0315)	(0.0267)	(0.0336)	(0.0334)
Panel B: Untouchability B (directly reported or kitchen)								
household untouchability	0.0986***	0.0929***	-0.00926	0.0232*	0.00812	0.00513	0.0208†	0.00594
	(0.0144)	(0.0135)	(0.0101)	(0.0102)	(0.00994)	(0.00942)	(0.0110)	(0.0107)
village untouchability^{-i}			0.303***	0.205***	0.166***	0.0586*	0.208***	0.169***
			(0.0307)	(0.0295)	(0.0287)	(0.0264)	(0.0312)	(0.0307)
ln (consumption/capita)^3		✓		✓	✓	✓	✓	✓
own caste group × religion		✓		✓	✓	✓	✓	✓
extended controls					✓	✓		✓
state fixed effects						✓		
n (rural households)	27,320	27,320	27,320	27,320	27,320	27,320	22,833	22833

The dependent variable is an indicator for the household reporting open defecation. Village untouchability^{-i} is the fraction of household's other than the respondent's who report practicing untouchability, in the respondent's village. Monthly consumption per capita is included as a cubic polynomial. "Extended controls" are household size in persons, whether the household owns or cultivates land, whether the household has a literate member, the educational achievement of the head of the household, the education of the head of the household's father, and four sets of indicators for whether men and women listen to the radio or read the newspaper sometimes or regularly; each extended control variable is entered fully non-parametrically as a set of separate indicators for each level or count of the variable. Standard errors clustered by village in parentheses; † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4: Untouchability and village-level change in open defecation, 2005 to 2012

	(1)	(2)	(3)	(4)
	change in village open defecation (percent decrease)			
village untouchability practice, 2012	13.09**	12.59**	13.46**	15.50***
	(4.282)	(4.398)	(4.634)	(4.519)
village average consumption change		6.574	6.591	6.333
		(4.360)	(4.344)	(4.230)
village open defecation, 2005			-5.317	-23.24†
			(10.08)	(11.89)
caste & religious composition				$F_{7,1317} = 6.35$
				$p < 0.001$
constant	-22.57***	-24.39***	-20.64*	733.7**
	(2.087)	(2.219)	(8.570)	(272.4)
n (rural villages)	1,329	1,329	1,329	1,329

The dependent variable is the village-level reduction in the fraction of households reporting open defecation, as a percent of the initial fraction of households defecating in the open. "Village untouchability practice, 2012" is the fraction of the village reporting practicing untouchability B (directly reported or kitchen); untouchability was not observed in the 2005 IHDS. Consumption change from 2005 to 2012 is in units of ln of rupees per month per capita. "Caste and religious composition" is a set of measures of the fraction of households in the PSU in each of eight groups: Brahmin, other forward caste, OBC, Dalit, Adivasi, Muslim, a group for Sikh or Jain, and Christian, with the first four caste groups defined by the IHDS to be subsets of the 84% of rural households which are Hindu. Robust standard errors in parentheses (data are collapsed by cluster); † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5: Village practice of untouchability is, if anything, correlated with correct health beliefs

	(1)	(2)	(3)	(4)	(5)	(6)
correct about:	chulha smoke	diarrhea hydration	malaria cause	milk in pregnancy	male sterilizaton	colostrum
Panel A: Untouchability A (Direct household report)						
village untouchability^{-i}	0.0579*	0.128**	0.187***	-0.0212	0.000190	0.00587
	(0.0258)	(0.0394)	(0.0268)	(0.0407)	(0.0470)	(0.0288)
household untouchability	-0.00292	0.00976	-0.0227*	-0.00452	0.00160	0.0128
	(0.0104)	(0.0139)	(0.0108)	(0.0115)	(0.0152)	(0.00977)
n (female respondents)	22,811	22,817	22,811	22,057	18,207	22,814
Panel B: Untouchability B (Direct household report or kitchen)						
village untouchability^{-i}	0.0433†	0.155***	0.186***	0.0464	0.0442	-0.00458
	(0.0245)	(0.0375)	(0.0247)	(0.0371)	(0.0404)	(0.0268)
household untouchability	-0.0117	0.00540	-0.0209*	-0.00172	0.0102	0.00592
	(0.00940)	(0.0142)	(0.00946)	(0.0114)	(0.0147)	(0.00903)
n (female respondents)	22,812	22,818	22,812	22,058	18,208	22,815
Panel C: Open defecation behavior and health beliefs						
open defecation	0.0000237	-0.0221	-0.000944	0.00587	0.0339†	-0.0426***
	(0.0100)	(0.0136)	(0.00961)	(0.0125)	(0.0174)	(0.00871)
n (female respondent)	22,924	22,930	22,924	22,167	18,291	22,927

Each column by panel combination is a separate regression. Each dependent variable is an indicator for the adult woman respondent correctly answering the question about that column's health belief. Village untouchability^{-i} is the fraction of household's other than the respondent's who report practicing untouchability, in the respondent's village. Open defecation is an indicator at the household level. Each regression includes the most complete set of controls from main results table 3: consumption as a cubic polynomial, caste by religion indicators, state fixed effects, and the set of extended controls. Standard errors clustered by village in parentheses; $\dagger$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 6: Household practice of untouchability is positively associated with knowing doctor

	(1)	(2)	(3)	(4)
dependent variable:	knows doctor among relatives/caste/community			
household practices untouchability	0.0172†	0.0163†	0.0231**	0.0250**
	(0.0101)	(0.00977)	(0.00876)	(0.00907)
$\ln(\text{consumption})^3$		✓	✓	✓
own caste group × religion		✓	✓	✓
state fixed effects			✓	✓
n (rural households)	27,261	27,261	27,261	22,800
sample:	full	full	full	Hindu

The dependent variable is an indicator for the household respondent answering yes to "Do you or any members of your household have personal acquaintance" with a doctor "among your relatives/caste/community;" the mean of this variable is 0.167. Untouchability is version B: reported or kitchen. Standard errors clustered by village in parentheses; † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 7: Controls for health beliefs predict sanitation, but do not change main result

	(1)	(2)	(3)	(4)	(5)	(6)
	dependent variable: household open defecation					
village untouchability A^{-i}	0.0743**	0.0739**	0.0732*			
	(0.0267)	(0.0285)	(0.0285)			
household untouchability A	-0.00276	-0.000502	0.000161			
	(0.00961)	(0.0107)	(0.0107)			
village untouchability B^{-i}				0.0586*	0.0569*	0.0565*
				(0.0264)	(0.0282)	(0.0282)
household untouchability B				0.00513	0.0119	0.0126
				(0.00942)	(0.0106)	(0.0106)
health beliefs		$F_5 = 5.61$	$F_5 = 5.57$		$F_5 = 5.61$	$F_5 = 5.60$
		$p < 0.0001$	$p < 0.0001$		$p < 0.0001$	$p < 0.0001$
doctor social contact			-0.0250†			-0.0259†
			(0.0140)			(0.0141)
other health social contact			0.00869			0.00861
			(0.0143)			(0.0143)
all controls from table 3	✓	✓	✓	✓	✓	✓
n (rural households)	27,320	22,016	22,016	27,320	22,017	22,017

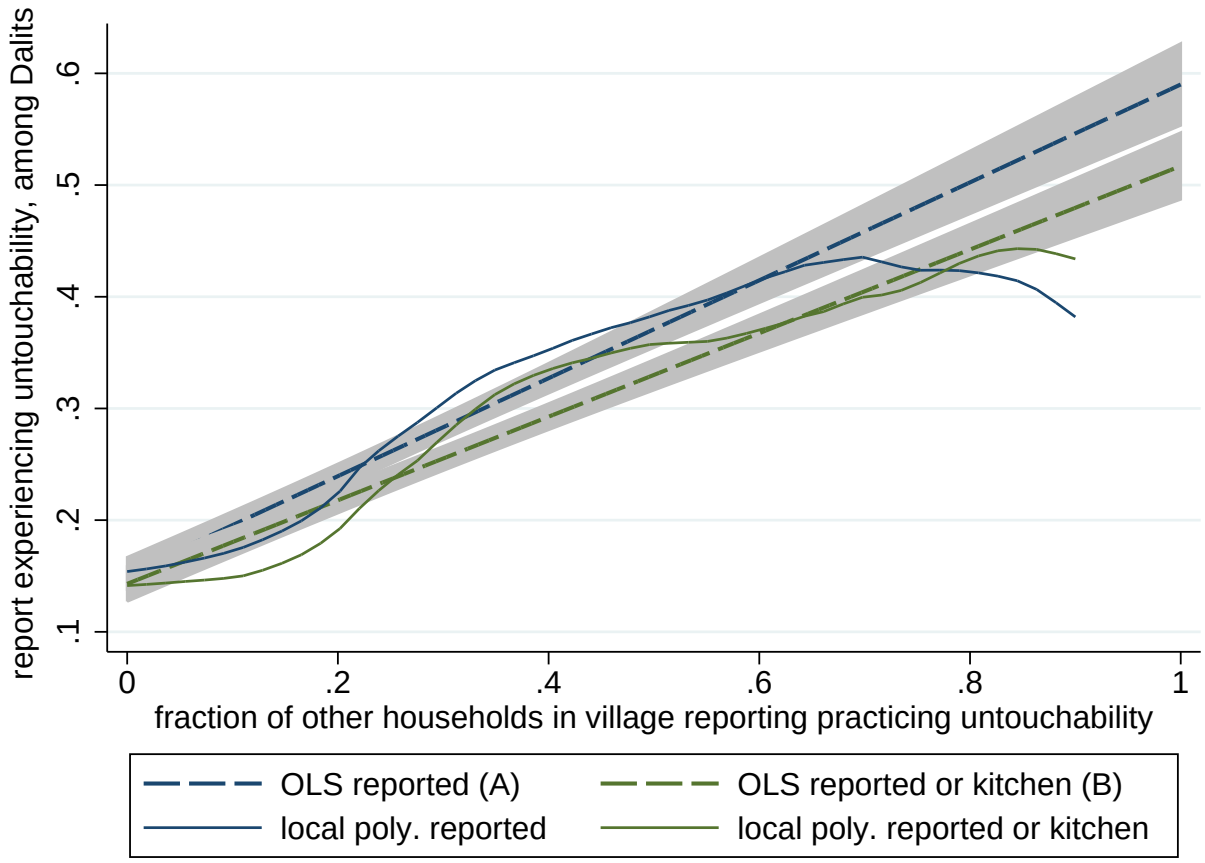
The dependent variable is an indicator for household open defecation. Village $\text{untouchability}^{-i}$ is the fraction of household's other than the respondent's who report practicing untouchability, in the respondent's village. Open defecation is an indicator at the household level. "Health beliefs" is the set of dependent variables from table 5. "Doctor social contact" and "other health social contact" are indicators for the household reporting knowing somebody in their family, caste, or community, as in table 6. Each regression includes the most complete set of controls from main results table 3: consumption as a cubic polynomial, caste by religion indicators, state fixed effects, and the set of extended controls. The regressions in columns 1 and 4 are identical to those in panels A and B of column 6 of table 3. Standard errors clustered by village in parentheses; † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 8: Discussion: The practice of open defecation and untouchability across Indian states

	(1)	(2)	(3)	(4)	(5)
	fraction of rural households that defecate in the open				
practice untouchability B	1.123***	0.628**	0.554**	0.549*	
	(0.192)	(0.182)	(0.197)	(0.200)	
practice untouchability A					0.628*
					(0.242)
literacy		-1.717***	-1.778***	-1.718**	-1.769**
		(0.323)	(0.376)	(0.505)	(0.526)
poverty			0.784	0.982	1.055
			(0.674)	(0.829)	(0.799)
average consumption			0.169	0.167	0.181
			(0.199)	(0.253)	(0.254)
much confidence in politicians				-0.254	-0.262
				(0.416)	(0.392)
some confidence in politicians				-0.133	-0.119
				(0.226)	(0.243)
NREGA work				-0.186	-0.175
				(0.158)	(0.160)
in women's group				0.198	0.187
				(0.165)	(0.169)
test addition			$F_{2,27} = 0.74$	$F_{4,23} = 1.51$	
			$p = 0.49$	$p = 0.23$	
n (states)	32	32	32	32	32
R^2	0.480	0.712	0.726	0.768	0.764

The dependent variable open defecation and independent variables literacy, poverty, confidence in political leaders, household participation in NREGA, and household participation in a women's group are all computed as a fraction of rural households in a state. Robust standard errors in parentheses (data are collapsed to state averages); † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Figure A1: Appendix: More Dalits report experiencing untouchability where more of their neighbors report practicing it.



Observations in this graph are rural Dalit households.